Sediment Supply to the Semi-endorheic Raya Graben (Northern Ethiopia)

Biadgilgn-Demissie[1, 2], Amaury Frankl[2], Miro Jacob[2], Tesfaalem Ghebreyohannes[1, 2], Mitiku Haile[3], Jan Nyssen[2]

1: Department of Geography and Environmental Studies, Mekelle University, Ethiopia
2: Department of Geography, Ghent University, Belgium
3: Department of LARMEP, Mekelle University, Ethiopia

(biadgilgn.demissie@Ugent.be or biadgilgnd@gmail.com)

Abstract

Sediment yield relies on bio-physical and hydro-climatic factors that control erosion and sediment delivery in drylands. Sediment supply for the last six decades in the semi-endorheic Raya graben bottom (northern Ethiopia) was measured as aggradation thickness under road bridges of known age. In order to quantify vegetation cover in the escarpment, NDVI was analyzed from Landsat imagery of 2000. Extreme daily rainfall and mean total rainfall of the rainy season (July and August, 2013 and 2014) for the catchments draining to the bridges were mapped using the cokriging geospatial interpolation method, based on daily rainfall data in 21 stations (elevation ranging from 1432 – 3579). A modified rational method was used to estimate peak discharge for the ungaged catchments based on event-based empirical precipitation and discharge measurements made in two rivers (Etu and Hara) in 2013 and 2014. Results show that the annual deposition thickness at the bridges built in 2011 (average = 13.2 cm/year, n = 3) is the highest in contrast to that at the bridges built in 1951 (average = 1.7 cm/year, n = 6). This is perhaps related to the increasing trend of precipitation and then runoff in the study area and intermediate sediment removal. At the bridges built in 2002 (n = 21) there was 72.5 ± 64.4 cm/year thickness of sediments deposited; these data were used for further analysis to link sediment volume and catchment characteristics. The results show that catchment area ($R^2 = 0.80$, $p < 0.0001$) and calculated peak discharge ($R^2 = 0.78$, $p < 0.0001$) were positively correlated with sediment volume in the graben bottom. Whereas mean total precipitation of the rainy season (July & August) had a weak positive correlation significant at the 90% confidence interval ($R^2 = 0.20$, $p = 0.1$), there was an inverse relationship between NDVI of the catchments in 2000 and sediment volume under the bridges ($R^2 = 0.26$, $p = 0.05$). Hence, in order to reduce the sediment supplies in the floors of the Raya graben and similar grabens, increasing the vegetation cover in the escarpment is of a primary condition.

Keywords: Sediment supply, graben bottom, peak discharge, extreme precipitation, Rift Valley